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THE NAMING AND RECOGNITION OF WRITTEN SYMBOLS IN APHASIC AND ALEXIC PATIENTS

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A test consisting of sixty-six written symbols was administered to matched groups of controls, aphasic patients, and alexic patients. The test was designed to determine how the naming and recognition of symbols is affected in aphasia and whether the difficulties associated with alexia are restricted to verbal symbolic materials. Aphasics had more difficulty in symbol naming than control groups; posterior aphasics had more difficulty in recognizing symbols than anterior aphasics; alexic patients had considerable difficulty in naming and recognizing all symbolic categories. The relative difficulty of the various symbolic categories was consistent across all subject groups except the alexic subjects. The results are discussed in terms of the nature of naming, recognition, and reading of symbolic materials; the relationship between alexia and other disturbances of language and symbol use: the mechanisms which may mediate symbol processing under conditions of cortical injury.

The capacity to employ symbolic materials is of crucial importance in contemporary society. Individuals must deal with words, numbers, trademarks, and insignias, as well as pictorial materials like maps, diagrams, and paintings. It has sometimes been maintained that certain of these categories are more "symbolic" because of their arbitrary or phonetic character (Peirce, 1955). Even if such an argument has validity, it does not immediately suggest whether a given mark qualifies as a symbol. Indeed, logical analysis has suggested that various written marks form a continuum of symbols, rather than a dichotomy of symbolic and nonsymbolic materials (Goodman, 1968; Gardner, Howard, and Perkins, 1973). For present purposes, therefore, *any mark* which performs a referential function (denoting, representing, or exemplifying an element, object, or concept) will be considered a symbol. What happens under conditions of brain damage to the capacity to process symbols is the subject of this report.

Some commentators have maintained that aphasia affects the entire symbolic faculty, including nonlinguistic symbols (Head, 1926; Bay, 1964). In its strongest form, this view appears untenable: it has been shown that aphasic patients can utilize pictorial symbols and can make their way about a symbol-laden environment (Luria, 1970; Goodglass and Kaplan, 1972). An alternative view holds that there may be specific syndromes which affect, and other syndromes which spare, the capacity to deal with each category of symbol (Nielsen, 1946; Geschwind, 1965). The difficulty with most descriptions of such specific disorders

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is that they do not report in detail how a patient fares with other symbolic media. Consequently, it is not possible to tell whether the patient has a category-specific asymbolia, or whether his asymbolia is more pervasive.

The present study examines the capacity of patients with general linguistic disorders and patients with a clinically diagnosed asymbolia (alexia) to name and recognize symbolic materials. Of special interest was whether the alexic patients would have difficulty only with the verbal symbols. Information was obtained on the order of difficulty of various categories of symbols and the kinds of errors made and strategies employed. Evidence was also obtained on the relationship between the naming, "reading", and recognizing of various symbols; the tenability of the claim that brain damage can selectively impair the capacity to deal with certain symbols; the factors which facilitate the processing of certain categories of symbols.

Methods

Subjects

The subjects were all male, right-handed patients at the Boston Veterans Administration Hospital. Forty subjects were diagnosed as aphasic; 15 had focal lesions restricted to the anterior (frontal lobe) region of the dominant hemisphere; 15 had focal lesions restricted to the posterior (temporal-parietal) regions of the dominant hemisphere; 10 were global aphasics with damage extending from the anterior to the posterior regions of the dominant hemisphere. Lesions were localized according to brain scans (available in nearly all cases), EEG records, surgeons' reports, field defects, and clinical findings. Each patient admitted during the period of the study to the Aphasia Research Unit who conformed to one of these diagnostic categories and whose clinical condition was stable was given the test. In addition, 10 normal control patients taken from nonneurological wards of the hospital and 15 brain-damaged control patients with no discernible language difficulties also took the test. The latter group was composed of 10 patients with Korsakoff syndrome and five with focal damage to the right anterior or right posterior portions of the brain. The patients were all of comparable educational backgrounds (high-school level) socio-economic background (working class) and age (median 52).

In addition, six patients diagnosed clinically as alexic were given part I of the test; five of these patients were given part II as well. These patients were all individuals with damage to the dominant hemisphere whose primary difficulty was in reading letters and/or words. One had mild agrammatism, the rest had mild to moderate naming difficulty, but in each case alexia dominated the clinical picture. Z-scores of all alexic patients on reading were below the norm of an aphasic population, and below the mean of the present aphasic group; their scores on naming were above the norm of the aphasic group (Goodglass and Kaplan, 1972). The severity of aphasia, as judged by severity rating scores on the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1972) averaged 3.3 for the alexic patients (adequate daily conversation) and 1.0 for the aphasic patients (listener carries the burden of conversation); there was little overlap between the two groups.

Finally, among the posterior aphasic patients, there were five individuals diagnosed clinically as having anomia—an aphasic difficulty with naming due primarily to pathology in the region of the angular gyrus (Goodglass and Kaplan, 1972; Geschwind, 1965). These subjects provided an instructive contrast with the alexic subjects, for their aphasia was relatively mild (mean severity rating of 2.8). On clinical examinations their naming difficulty was judged to extend across a range of objects and symbols.

Materials

Nearly 200 symbols from a variety of categories were drawn in black ink, scribbled in color (samples of color), printed in black type (verbal materials), or clipped from magazines (faces and objects) and pasted onto index cards. In a pilot study, all symbols were shown to 10 control subjects; unfamiliar ones were eliminated and the remaining symbols were grouped into intuitively meaningful categories. After this selection process a test of 66 items was assembled. The items fell into 11 categories, which run the gamut of semiotic systems (Morris, 1946; Goodman, 1968). Five of the items were selected from the most common exemplars of that category while the sixth was relatively more difficult to identify. Test items are listed here, with the most difficult member of each category placed last: PART I: *Numbers* (2, 4, 6, 7, 9, 13); *Letters* (A, E, M, R, S, V); *Colors* (red, orange, yellow, green, blue, grey); *Animals* (dog, monkey, horse, cat, cow, rhinocerous). PART II: *Punctuation marks* (question mark, period, 'and' sign, comma, exclamation point, quotation marks); *Objects* (camera, telephone, watch, sewing machine, car, magnifying glass); *Number-related signs* (plus sign, division sign, Roman four, eleven on dice, percentage sign, square root radical); *Faces* (Richard Nixon [president], Spiro Agnew [vice-president], Walter Cronkite [news commentator], Elizabeth Taylor [film actress], Mamie Eisenhower [wife of a president], Nelson Rockefeller [political figure]*; Printed words (and, advantage, knockout, moonlight, thirty, extraordinary); Words in various settings or fonts (blue* [in red ink], *Lum* [in hand-written block letters] *one-way* [as on a road sign], *Coke* [on a soda-bottle], *me* [in Fraktur], *hydroelectric* [in cursive script]*); Miscellaneous signs* (sergeant's stripes, dollar sign, SOS [in morse code], nine-of-spades, swastika, g-clef).

Procedure

A subject was shown a sample symbol and asked to identify it. If the subject did not comprehend the instructions, he was drilled on practice items until he understood the procedure. If he was unable to produce recognizable words, he was instructed to point to one of three fingers, each of which was raised at the time that one of the multiple choices was given. Additional training was required in teaching this response procedure to severely aphasic subjects.

Once instructions were understood, the subject was asked to identify the first test item. If he did not produce the correct name within fifteen seconds, he was given a category cue (e.g., "This is a number"). If, after an additional fifteen seconds, the subject had not produced the correct name, he was given three choices: the correct answer, an answer belonging to the same semantic category (e.g., another number), an answer which sounded like the correct answer (a rhyming word).

Depending on the severity of the aphasia, the test was administered either at one sitting or in two successive sessions. Subjects were required to give the precise answer specified beforehand and no synonyms or paraphrases were accepted. If there was any reasonable doubt whether the subject had produced the correct answer, he was given the three choices.

The items in each part of the test were randomly ordered without regard to category. All subjects took Part I before Part II, with half the subjects in each group beginning with the first item in each part, the other half with the last item in each part. All subjects took the entire test except for the global aphasics and one alexic patient who took only Part I.

An abbreviated version of the Ishihara pseudo-isochromatic test was given to any subject who had trouble in naming or recognizing the colors. One subject who could not correctly trace the figures on the cards was dropped from the study and is not included in any analysis.

Results

Naming

Each subject was given a naming score, the number of symbols correctly identified in both parts of the test during the 30-second period preceding the multiple choices. An analysis of variance yielded a significant difference among the four subject groups of normal controls, brain-damaged controls, anterior aphasics and posterior aphasics ($F = 8.68$, $p < 0.01$). Because of the small number of subjects alexics were not included in this analysis. A Scheffé post-hoc comparison between all pairs of means revealed a significant difference ($p < 0.05$) between the scores of the aphasics and the control groups, with anterior and posterior aphasics performing significantly worse than brain-damaged and normal controls. There was no significant difference between anterior and posterior aphasic groups. Control subjects needed choices on an average of 8.7 items, brain-damaged controls on 11.4, anterior aphasics on 21.4, posterior aphasics on 29.7 of the 66 items. Anomic subjects (included as part of the posterior group) needed help on 32.0 items, alexic subjects also needed help on 32.0 items. Thus, despite their relative preseveration of other language functions, the alexic patients have as much or more difficulty in naming written symbols than do other aphasics with focal lesions.

Recognition

Each subject was given a recognition score, the number of symbols in both parts of the test correctly identified either during the 30-second naming period or from the multiple choices. An analysis of variance indicated that there was a significant difference among anterior, posterior, brain-damaged controls, and normal controls ($F = 11.87, p < 0.01$). A Scheffé post-hoc comparison indicated that the posterior patients scored significantly worse ($p < 0.05$) than the other subject groups, but that there was no significant difference among the other three groups in the number of correct responses. The average number of recognition errors was quite small, indicating that most subjects recognized most symbols. The controls averaged 2.1 errors, the brain-damaged control patients 4.0, the anterior aphasic patients 4.8, and the posterior aphasics 11.5 errors per subject, all well above chance performance. Of the two small groups of special interest, anomics averaged 9.8 errors, the alexics 8.6 errors per subject.

While the anterior aphasics and the brain-damaged controls made approximately the same number of recognition errors, this result is somewhat misleading. The brain-damaged controls made nearly half of their errors (28 of 60) on "face identification", a result due in all likelihood to the particular composition of the brain damaged control group. When "faces" are omitted from the analysis, the anterior aphasics make significantly more errors than the brain-damaged controls ($t = 2.27, p < 0.05$). An analysis of variance on the number of correct recognitions by controls, brain-damaged controls, and anterior aphasics produced a group differences just short of significance ($F = 2.52$, $p < 0.06$). These results suggest that the anterior aphasics did not recognize symbols quite as well as the two control groups, but that a greater difference exists between the performance of the anterior and the posterior aphasics.

An analysis of variance was also performed on the number of symbols correctly recognized during Part I of the test, the only portion administered to the global aphasics. This analysis revealed a significant difference among groups ($F = 32.88, p < 0.01$), the largest portion of which was contributed by the global aphasics. The latter group averaged 8.5 errors out of 24 items on this portion, while all other subject groups averaged less than one recognition error per subject. Nonetheless, when the globals are deleted from the analysis, there still is a significant difference among the subject groups: (F = 2.91, $p < 0.05$); a Scheffé post-hoc comparison revealed that the posterior aphasics performed worse than the other groups ($p < 0.05$).

Order of Difficulty of the Various Symbols

Of interest was the relative difficulty of the different types of symbols for each of the subject groups. The general configuration of results can be seen in Fig. 1 and 2. On the first, simpler portion of the test, the two control groups have virtually perfect performances, the only exception being occasional difficulty in naming the color *grey*. Conversely, global aphasics need multiple

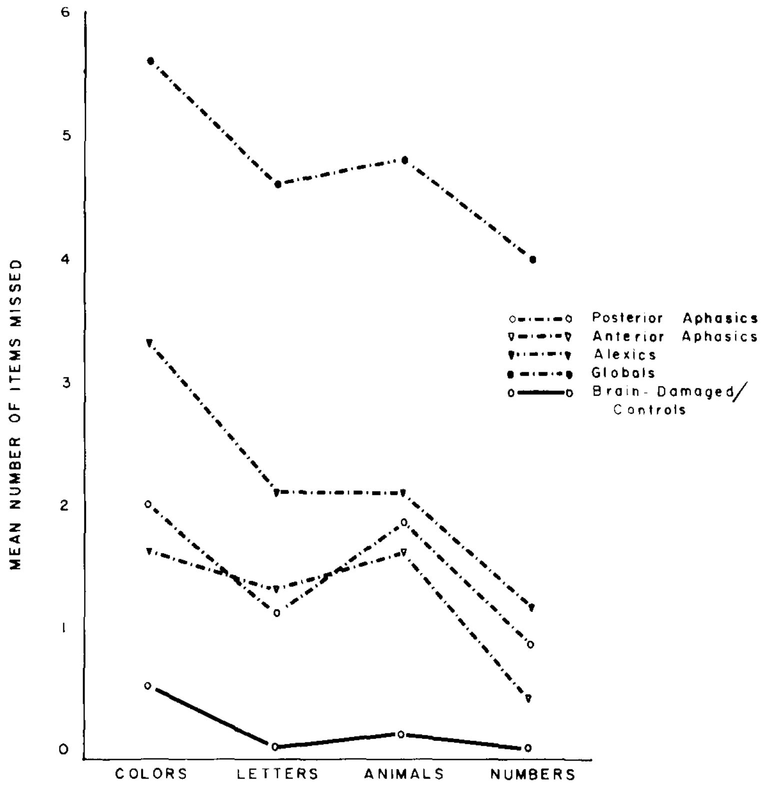

FIG. 1. Mean number of items in each symbolic category in Part I of the test which subjects were unable to name. Brain-damaged and normal controls have been combined into one group.

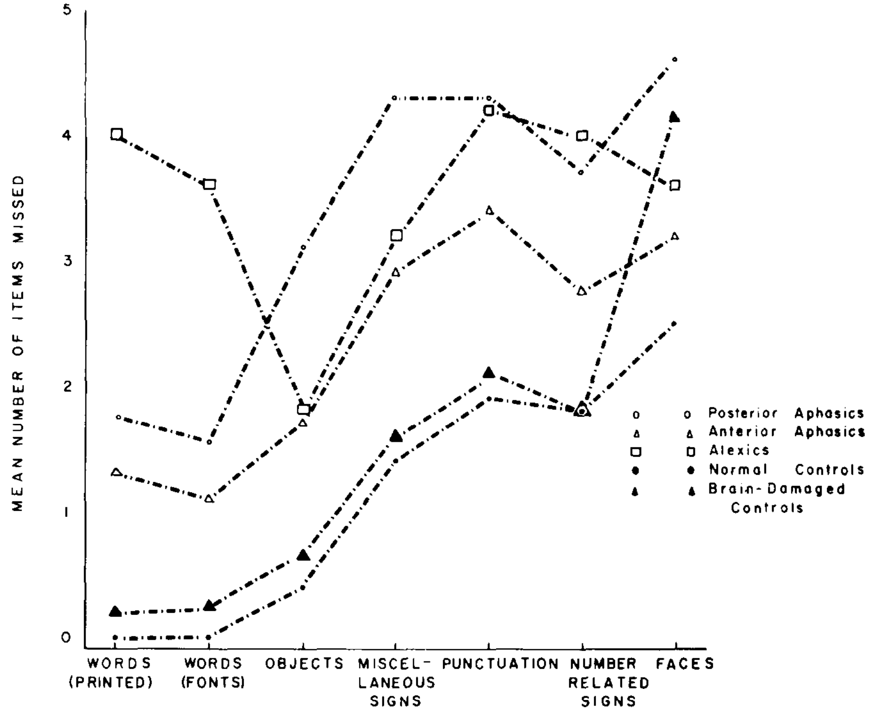

FIG. 2. Mean number of items in each symbolic category in Part II of the test which subjects were unable to name.

choices on an average of five items in each category. The three other groups of aphasic subjects had generally similar performance, requiring multiple choices on an average of two of the six items; overall the alexic subjects are slightly worse. When the categories are ranked in order of the number of items missed by each subject group, an identical ordering is found, with numbers the easiest, colors the most difficult. The posterior patients do worse than the anterior aphasics on all items except for letter naming, a finding previously noted by Goodglass, Klein, Carey, and Jones (1966).

On the second portion of the test, there is strong similarity in the performance curves of the various subject groups. If alexic patients are excluded, there is a Kendall (1955) coefficient of concordance of 0.90 among the subject groups in the relative number of errors per symbolic category ($p < 0.01$). Including alexic subjects in the comparison reduces the correlation to 0.63 ($p < 0.01$). When all other aphasic groups are combined, and contrasted with the alexic group, there is a nonsignificant correlation of 0.58 between alexics and aphasic patients. In contrast, there is a significant correlation of 0.96 between the order of difficulty for anomics and all other aphasic patients.

To determine whether the relatively low correlation between the alexic subject's performance and that of other aphasic groups was due to the alexic group's difficulty with verbal materials, the two categories which included words were dropped from the comparison. On the five remaining categories, the order of difficulty for the alexic subjects correlated 0.30 with the order of difficulty for the other aphasic subjects and 0.30 with the order of difficulty for the anomic subjects.

In contrast, there was a perfect correlation in the order of difficulty between the anomic subjects and the other aphasic subjects (excluding the alexics). Because of the small number of categories and subjects, it would be misleading to give significance levels or to overinterpret these differences in correlation. Nonetheless these orderings do suggest that, in addition to having difficulty with a full range of symbolic materials, the alexic patients may also have a qualitatively different performance profile on the test, one not entirely due to their difficulty with verbal materials.

The number of items in each category which alexic patients were unable to name was compared with the number of items which the posterior patients and the anomic patients were unable to name. The alexic patients performed better than the anomic patients only on the categories of faces and objects, and better than the posterior patients on faces, objects, and miscellaneous signs. Indeed there is a double dissociation between aphasics and anomics in their respective abilitites to name objects and words. All five anomic patients made more errors in naming objects than in naming words; all five alexic patients made more errors in naming words than in naming objects ($p < 0.04$ on the binomial distribution).

Other Findings

An analysis of errors on multiple choice revealed no significant difference between any subject groups on the number of acoustic or semantic responses. In general semantic and acoustic choices were made with equal frequency, though there was a slight tendency on the part of the less severely impaired subjects to make more semantic errors.

Subjects' strategies were examined. When subjects could not immediately identify objects, they often searched around for the physical object itself or pretended to be holding the object, presumably with the expectation that cues from sensory modalities other than the visual ones would aid in recognition or naming. When examining symbols which belonged to a familiar category, they would frequently "run through" all the instances of the category which they could think of. Patients with alexic difficulties would sometimes wait for the category cue, and then list all possible names in an orderly fashion (counting, exhaustively listing the alphabet or the color wheel).

There are frequent errors within categories for all subjects. Such confusion (spades for clubs, President for Vice-President) is likely to arise whenever identification of a symbol is not immediate, but category membership can be established. Overall there was a surprising amount of difficulty in providing the correct color names without multiple choice; providing the names of samples of color may be an unfamiliar (or abstract) task for this patient population. Even the most severely global aphasics, however, tended to make errors within the category; only seldom was a color called a number, or a number a letter.

Discussion

The results confirm certain previous findings while supplementing current views on the processing of symbols. It has again been shown that brain-damaged subjects perform worse than normal controls on a cognitive-perceptual task (Teuber, 1960), those patients with dominant hemisphere disease being particularly impaired in tasks dealing with linguistic materials (Milner and Teuber, 1968). When the number of errors in recognition is considered, patients with posterior damage are substantially worse than anteriors; when the number of naming errors is computed, the difference between anterior and posterior patients is reduced. This finding confirms that naming errors have little localizing value (Head, 1926; Goldstein, 1948; Gardner, 1973a) but that comprehension of linguistic material is more likely to be impaired in posterior patients (Goodglass and Kaplan, 1972; Luria, 1970). Patients with damage in both the anterior and posterior regions do much worse on all aspects of the task.

Supplementing this information are findings on the relative difficulty of the particular symbolic categories. Normal and brain-damaged control subjects make virtually no naming errors on the most familiar and simplest items—numbers, words, letters, colors, animals, and objects. They make a larger number of errors in naming and recognition of the rarer, more specialized kinds of signs. All groups had some difficulty in naming faces, a finding which may be due in part to their lack of interest in political and cultural events.

It might appear anomalous that the brain-damaged control did so poorly on face recognition; however, the two groups of brain-damaged controls available were both suffering from conditions in which facial recognition would be fragile. Patients with right hemisphere disease are known to have difficulties making fine discrimination of elements like faces (Milner and Teuber, 1968; de Ajuriaguerra and Hécaen, 1964); the Korsakoff patients have retrograde amnesia and so would not be able to recognize individuals from the recent past (Talland, 1965). Poor performance on face identification should tentatively be considered an artifact of the particular control groups used.

All subject groups except for the alexics displayed a similar order of difficulty with the various categories of symbols. While this finding is less dramatic than results with greater implications for localization of function, it does provide information relevant to the theoretical issues raised above. The present results suggest that recognition and naming of symbols is impaired across-the-board in aphasic patients, in the same relative order as in non-aphasic subjects. In the absence of normative data, it seems plausible to assume that those symbols which are more familiar and require less specialized knowledge, and those symbols for which well-established routines of decoding exist (words) are easier to identify. There is no evidence that simplicity of the symbols in a geometric (perceptual) sense influences the recognition scores, except perhaps in the case of the right hemisphere patients (DeRenzi, Scotti, and Spinnler, 1969).

The alexic patients demonstrated an order of difficulty somewhat different from the other subject groups. Part of this difference was due to their difficulty in decoding written verbal materials; yet even when the verbal materials are eliminated, the alexic patients still have a different profile, with faces and objects being relatively easier. The difference is brought out by a comparison with the anomic patients: while the latter group is supposed to have difficulty with naming all kinds of elements, their profile of results coincided exactly with that of other aphasic groups, while differing from that of the alexic subjects.

These findings call into question the commonly stated assumption that alexic patients have an isolated difficulty in reading. The alexic patients in this study exhibited appreciable difficulty in naming all symbolic materials presented, including some which cannot legitimately be termed *verbal*. The results also challenge the widespread assumption that verbal symbols are qualitatively different from other kinds of marks on the page. The findings here are consistent with the conclusion that reading difficulties are allied to a general difficulty in identifying written symbols, and that the decoding of verbal symbols shares properties with the decoding of other symbolic materials (Albert, Yamadori, Gardner, and Howes, 1973).

Against the view just put forth it can be argued that the patients included in this study were not pure alexics. Indeed, while their general communicative ability was good, they all showed some naming difficulty. Yet it must be emphasized that each of the patients was diagnosed clinically by competent neurologists as being alexic and that their reading scores were substantially lower than other subscores on the Aphasia Test. Of the numerous studies of reading and naming capacities in alexic patients (Benson and Geschwind, 1969) none has included a systematic test of symbol reading of the type used here; *as a result it is not known whether allegedly "pure" alexics would have scored as well as normal subjects on all categories save those including verbal materials.* The present results suggest that at least some patients diagnosed as alexic show an across-the-board naming difficulty with written symbolic materials, in which verbal materials are most severely impaired, and the naming of objects and of faces relatively spared. In between these extremes are other categories which are neither so arbitrary, familiar, and conventionalized as verbal material, nor so iconic and related to the physical world as faces and inanimate objects. This conclusion does not deny that, in rare cases, there may be isolated disorders in reading verbal materials (Geschwind, 1962).

The findings caution against an uncritical division of visual elements into those which can be read, and those which can be named. While verbal materials are distinguished by the existence of a phonetic system for producing and decoding them, it is not known whether this system is necessarily employed in silent and oral reading (Kolers, 1970) nor is it known whether analogous psychological processes are involved in decoding numbers, punctuation marks, or other kinds of symbols (Albert, Yamadori, Gardner, and Howes, 1973). Indeed the word ''reading'' seems traditionally to have been applied to those symbols which are difficult to identify unless they can be orally named. The aphasic patient who cannot emit the word ''apple'' has alternative means of indicating his knowledge of what an apple is: the patient who cannot say ''V'' or ''but'' has limited means of showing his recognition of that configuration. A patient may be diagnosed as alexic because, when shown an apple, he is able to say something acceptable as a name, whereas, when shown a letter or word, he can do relatively little if he fails to produce its name or ''read it''. Here the isolated disorder is in the eye of the clinician.

There remains the question of why certain symbols, notably numbers and objects, should be relatively easier for the alexic to deal with (Geschwind, 1962; Gardner, 1973b). The present results are consistent with Geschwind's (1962) position that alexics can identify numbers with relative ease because, like objects and pictures, these symbols arouse associations in a variety of modalities (tactile, kinesthetic, operational [(Piaget, 1970)]. In contrast, words, letters, and colors may be learned primarily or exclusively as visual entities with no strong extra-visual associations and thus can be recognized in a limited number of ways. Recognition and naming of the latter group of symbols is consequently dependent upon a discrete connection or association between the areas involved in visual synthesis and concept formation and the areas involved in production of the name (Geschwind, 1965; Konorski, 1967; Gardner, 1973a). On the other hand, the capacity to name objects and depictions of objects may involve associations between several sensory modalities or a combination of sensory modalities and the area involved in naming.

According to this view the visual and language processing areas in the alexic are intact, while the connections between them have been disrupted; those elements which involve kinds of sensory and motor associations to the naming area other than purely visual ones are more likely to be preserved (Gardner, 1973a,b; Geschwind, 1962, 1965). The finding that numbers, objects, and faces are relatively easy, while colors, words, and letters pose special difficulty for the alexics provides modest support for this theory. Pursuing this argument, the other groups of aphasic subjects should not have difficulties in associating visual forms with their names. Instead, their brain damage is more likely to involve the language areas directly. The kinds of difficulties experienced by aphasics would reflect the size rather than the placement of their lesion; their performance on this task would differ from that of normal or other brain-damaged subjects in degree rather than qualitatively. Should this view be correct it would help to reconcile the opposite views on linguistic and symbolic functioning outlined earlier (cf. Oxbury, Oxbury, and Humphrey, 1969). Those individuals suffering from disconnections between relatively intact sensory and linguistic areas should provide support for the position that particular symbolic capacities can be destroyed in isolation. Those with damage in the language areas *per se* should exemplify the opposing view that any linguistic disturbance results in some reduction of the capacity to utilize symbols.

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